PROCESSING TEMPERATURE EFFECTS ON LOW FAT, HIGH MOISTURE, BEEF FRANKFURTERS

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Story in Brief

Beef frankfurters were conventionally manufactured using four different fat and added moisture combinations (6/32 Treatment 1, 11/22 Treatment 2, 14/16 Treatment 3, 23/-2 Treatment 4) and processed at three different chopping temperatures (9^{o}, 12^{o} and 15^{o}C). Percent moisture was highest at 12^{o}. As temperature increased, Instron hardness values increased in both higher fat levels, with 23% harder. Fat levels 6% and 11% were softer than both the higher fat levels and were not influenced by temperature. Higher yields were obtained in the higher fat, lower added moisture treatments but the yields decreased as temperature increased. Purge loss recorded over an eight week period, was highest for the lowest fat, highest added moisture treatment and continued to increase as days increased. The highest fat, lowest added moisture level showed the lowest amount of purge. As temperature increased the amount of purge increased in the treatments containing the lowest fat and highest added moisture levels.

(Key Words: Beef Franks, Purge, Yield, Chopping Temperatures, Added Water.)

Introduction

Recent USDA cooked sausage labeling changes have given the red meat industry an opportunity to provide consumers with economical, low fat products. The changes allow for the total fat and added moisture level not to exceed 40%, whereas the traditional level was 30% fat and 10% added water. Fat content can easily be reduced by formulation. However, when water is not added in place of fat, a rubbery texture usually occurs. Increasing the water level beyond traditional levels tends to put increased pressure on the meat system. This increased pressure can partially explain the excess purge, higher cooking losses and soft texture normally associated with low fat beef products.

Endpoint processing temperatures have been established as critical control

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points in frankfurter manufacture in relationship to maximum protein extraction (Jones and Mandigo, 1982). However, these temperatures were not related to low fat/high moisture systems. Optimum temperatures for maximum protein stability were reported to be between 10^{o} and $12^{o}C$ (Gadea, 1990). Therefore, the objective of this study is to evaluate low/fat high moisture beef frankfurters using different chopping temperatures to maximize product yield and quality.

Materials and Methods

Beef shoulder clods and 50% fat beef trim, obtained locally, were individually ground (Grinder, Biro Mfg. Marblehead, OH) through a 1.27 cm plate. Samples taken from each were then reground through a .32 cm plate and analyzed for fat, moisture and protein (AOAC 1984) for formulation purposes. Appropriate lean, fat and water proportions for four different fat/added moisture levels were found using a least cost formulation computer program. Treatments were formulated for fat and moisture combinations of 10% fat, 30% added water (Trtmt 1); 15% fat, 25% added water (Trtmt 2); 20% fat, 20% added water (Trtmt 3); and 30% fat, 10% added water (Trtmt 4). However, when final product proximate analysis was performed actual fat/added water combinations differed from the targets (Table 1).

Percentage water (26%) for initial salt mixing was held constant among all treatments. This percentage was found by dividing the entire amount of water by the amount of lean formulated for treatment 1. The appropriate amount of water was mixed with the lean portion and spices (A.C. Legg, Birmingham, AL) in a 6 blade vacuum bowl chopper (Seydelmann K64, Robert Reiser, Canton, MA) for 30 seconds on low speed. The fat portion and remaining water was then added. This mixture was then chopped for 4 minutes on high speed with the last 30 seconds being under vacuum. All fat

Table 1. Target and actual fat/added water combinations.

	Target		Actual	
Treatment	Fat	Added Water[a]	Fat	Added Water[a]
1	10	30	6	32
2	15	25	11	22
3	20	20	14	16
4	30	10	23	-2

[a] Added water = moisture - 4(protein)

moisture combinations were chopped at 3 different endpoint chopping temperatures (9^{o}, 12^{o}, and 15^{o}C) by incorporation of the appropriate amount of crushed carbon dioxide (CO_2).

The batter was then stuffed into 32 mm cellulose casings (NOJAX^{ã}, Chicago, IL) and heat processed (Alkar 1 truck smokehouse, Lodi, WI). All treatments were replicated two times. Each treatment batch size was 11.33 kgs. Franks were allowed to cool for 18 hours at 4^{o}C before cooking yields were obtained by weighing the franks and dividing by the weight of the raw batter.

Frankfurters were then peeled and vacuum packaged (M855 Multivac, Kansas City, MO) 5 links per package. Samples from each treatment were frozen at -23^{o}C until proximate analysis and texture data could be obtained. The remaining packages were stored at 4^{o}C for purge analysis.

Purge loss was measured on 2 packages from each treatment stored at 40^{o}F. Each package was opened and the purge present was poured though a funnel into a 15 mL graduated centrifuge tube. The franks were then placed into the funnel to drain off any purge that was on the surface of the franks. Weights of the franks and empty packages were then recorded. The vacuum packages were dried in the smokehouse, to insure residual purge in the corners of the package was removed and weights were then obtained. Purge loss was then reported as a percentage of content weight. Purge was measured once a week for 8 weeks, with week 1 being the first week after production.

Compression values (quadruplicate) were determined by axially compressing a 3 cm sample 62.5% of it's height for two cycles with an apparatus attached to an Instron (Model 4500, Instron Corp. MA) which was set at a crosshead speed of 500/mm/minute and a 1kN load cell. Values obtained were hardness, springiness and cohesiveness.

Significant interactions ($P < .05$) between fat level and temperature and between temperature and day were analyzed using analysis of variance and linear regression. Significant regression lines are plotted and nonsignificant values are expressed as a line with no slope.

Results and Discussion

Table 2 shows the effect of temperature on proximate analysis. At 12^{o}C percent moisture was the highest. This can be directly related to the added water content. Although these differences were not statistically different, they are nonetheless very important to producers, where the added water content of their product could mean the difference between a profit or a loss.

Figure 1 illustrates the hardness of the franks with respect to a significant interaction between fat and temperature. Hardness is the force required to break the protein bonds of the product. This can be associated with the

Table 2. The effects of processing temperature on moisture, protein and added water.

Temperature,°C	Moisture		Protein		Added Water[a]	
	Mean	SE	Mean	SE	Mean	SE
9	69.43	2.78	13.05	.48	17.21	4.68
12	70.81	2.89	12.63	.50	20.27	4.79
15	68.15	3.28	13.64	.59	13.57	5.54

[a] Added water = moisture - 4 protein).

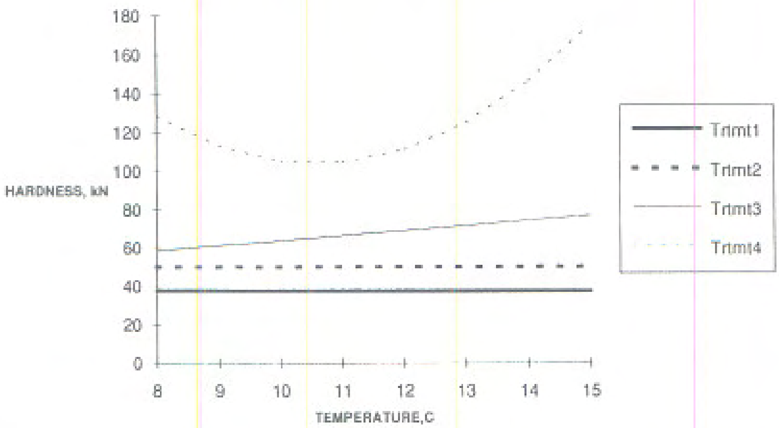

Figure 1. Hardness values associated with fat and temperature interactions.

amount of force required to compress a sample between molar teeth (Brady and Hunecke, 1985.). Eating qualities are very important in the marketability of franks, therefore it is essential to examine the hardness associated with varying fat and added water combinations. Treatment 4, higher fat content had higher hardness values than did those of other treatments. A higher peak force was noticed at 15°C for both treatments 3 and 4. This can be explained by increased protein extraction and less water holding capacity which would make the product harder. Temperature had no effect ($P<.05$) on the hardness values of treatments 1 and 2. The combination of higher added moisture and lower fat resulted in a much softer product, as shown by the much lower average hardness values. This may result in a detrimental consumer acceptance of low fat, beef franks.

Figure 2 illustrates the smokehouse yields obtained as a result of significant interactions between fat and temperature. In the two higher fat level treatments (Treatments 3 and 4), as temperature increased the yield decreased ($P<.05$). This may be due to the findings of Gadea (1990) where the optimum temperature for water holding capacity was $6^{O}C$, which is lower than those examined in this experiment. Yields for both treatments 1 and 2 were not effected by temperature and their average yields were lower than the other products.

The significant interaction between temperature and fat level in respect to purge loss is illustrated in Table 3. As the level of fat was lowered and added water increased from treatment 4 to treatment 1, the percentage purge increased. As expected, the treatment with the highest fat level and lowest added moisture level showed the lowest percentage purge. These findings are in agreement with those of Claus et. al (1989). Temperature had little effect on purge within fat level except in treatment 2, where $9^{O}C$ exhibited a higher percentage purge then either $12^{O}C$ or $15^{O}C$. In industry, many processors chop to endpoint chopping temperatures which typically range from 16-$18^{O}C$. It is believed that it is necessary to chop to these high temperatures in order to fully comminute the product and more specifically the fat portion. However, it is possible in some instances to have the product fully comminuted while still maintaining a low temperature, especially with the speed of modern day machinery and the use of carbon dioxide (CO_2) or liquid nitrogen.

The significant interaction between fat level and day is shown in Figure 3. As expected, the percentage purge increased as the number of days

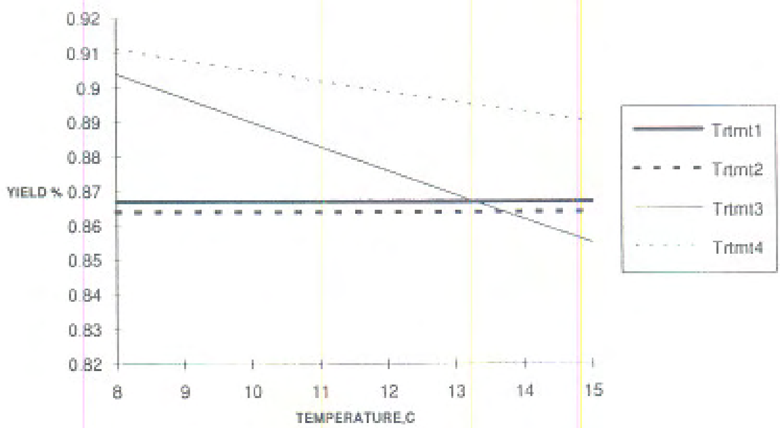

Figure 2. Smokehouse yields for fat and temperature interactions.

Table 3. The effect of temperature and treatment on percentage purge.

	Treatment							
	1		2		3		4	
Temperature, °C	Mean	SE	Mean	SE	Mean	SE	Mean	SE
9	6.69[a]	.46	2.06[cd]	.21	3.05[b]	.33	.55[e]	.09
12	6.58[a]	.45	2.74[bc]	.31	2.25[bcd]	.17	.72[e]	.04
15	6.14[a]	.61	2.67[bc]	.33	1.32[de]	.22	.57[e]	.03

[abcde] Means followed by different superscripts are different ($P<.05$)

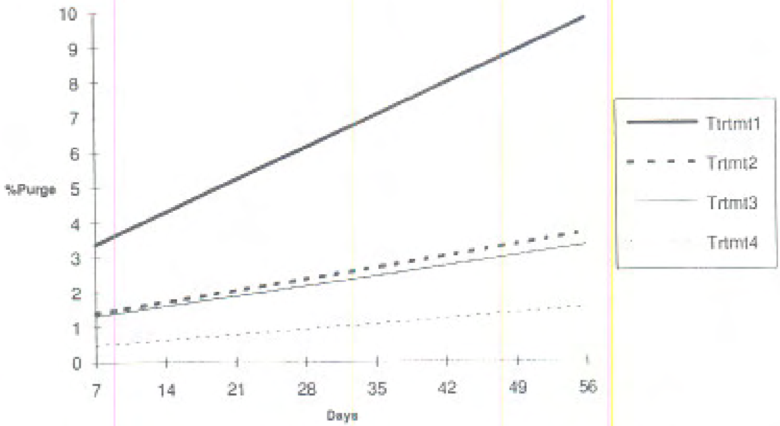

Figure 3. Significant interactions of fat and storage time purge.

increased. However, treatment 1 increased purge at a faster rate than did those of lower fat levels. This is probably due to the fact that more water was available in the product from the higher added moisture.

Summary

It is possible to manufacture high moisture, low fat, all beef franks. However, it is essential to maintain a low temperature during processing if the added water in the product is going to be bound and profitable yields are going to be achieved. Consumers will not purchase low fat franks if purge is not minimized. The frankfurters at lower fat higher added moisture levels were softer and this could be perceived by consumers as objectionable. In order for the beef industry to penetrate the highly competitive, low fat frankfurter market, additional research is essential to give the consumer a high quality product while allowing the processor to make a profit.

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